CLAIMS

WHAT IS CLAIMED IS:

1. A method to determine the presence of stratified 2-phase flow through a conduit, comprising:

(a) transmitting an ultrasonic signal through a first medium at a first time from a first ultrasonic transducer;

(b) reflecting said ultrasonic signal from the surface of a stratified flow of liquid through said conduit;

(c) receiving said ultrasonic signal at a second ultrasonic transducer second time;

(d) computing a first speed of sound for said first medium based at least in part on said first time and said second time;

(e) determining a second speed of sound for said first medium not based on said first ultrasonic signal; and

(f) determining whether stratified flow exists in said conduit by comparing said first speed of sound to said second speed of sound.

2. The method of claim 1, wherein said stratified flow is on the bottom of a pipeline and said first and second transducers are at the top of said pipeline.

3. The method of claim 1, wherein said second speed of sound is determined contemporaneously with said first speed of sound.

4. The method of claim 3, wherein said receiving is second speed of sound is determined by third and fourth ultrasonic transducers.

5. The method of claim 1, wherein said receiving is second speed of sound is determined by third and fourth ultrasonic transducers.

6. The method of claim 5, wherein said third and fourth ultrasonic transducers form a horizontal chord for travel of said second ultrasonic signal.

7. A method to determine the level of stratified 2-phase flow through a conduit, comprising:

(a) transmitting an ultrasonic signal through a first medium at a first time from a first ultrasonic transducer;

(b) reflecting said ultrasonic signal from the surface of a stratified flow of liquid through said conduit;

(c) receiving said ultrasonic signal at a second ultrasonic transducer second time;

(d) computing a first speed of sound for said first medium based at least in part on said first time and said second time;

(e) determining a second speed of sound for said first medium not based on said first ultrasonic signal; and

(f) deriving the level of stratified flow in said conduit by comparing said first speed of sound to said second speed of sound.

8. The method of claim 7, where said stratified flow is on the bottom of a pipeline and said first and second transducers are at the top of said pipeline.

9. The method of claim 7, wherein said second speed of sound is determined contemporaneously with said first speed of sound.

10. The method of claim 9, wherein said receiving is second speed of sound is determined by third and fourth ultrasonic transducers.

11. The method of claim 7, wherein said receiving is second speed of sound is determined by third and fourth ultrasonic transducers.

12. The method of claim 11, wherein said third and fourth ultrasonic transducers form a horizontal chord for travel of said second ultrasonic signal.

13. The method of claim 11, wherein said level of said stratified flow is determined based on the difference in said first speed of sound and said second speed of sound.

14. A level detector in a pipeline to measure stratified flow of less than 10% in said pipeline, comprising:

at least four ultrasonic transducers attached to said pipeline and positioned to reflect a first set of ultrasonic signals from the surface of said stratified flow and positioned to avoid reflecting ultrasonic signals from a surface of stratified flow;

a processor associated with said at least four ultrasonic transducers to calculate the presence of stratified flow in said pipeline based on a first speed of sound and a second speed of sound, wherein said first speed of sound is measured based on said first set of signals and said second speed of sound is measured based on said second set of signals.

15. The level detector of claim 14, wherein a difference between said measured speed of sound and said second measured speed of sound provides an indication of said level of said stratified flow.

16. The level detector of claim 14, wherein said stratified flow is on the bottom of a pipeline and said at least two of said four transducers are at the top of said pipeline.

17. A method to determine the amount of stratified flow through a conduit, comprising:

(a) transmitting through a first portion of said conduit a first ultrasonic signal from a first upstream location;

(b) receiving said first ultrasonic signal at a location downstream of said first upstream location;

(c) transmitting through said first portion a second ultrasonic signal from a first downstream location;

(d) receiving said second ultrasonic signal at a location upstream of said first downstream location;

(e) transmitting through said first portion of said conduit a third ultrasonic signal from a second upstream location, said third ultrasonic signal reflecting of a surface of said stratified flow;

(f) receiving said third ultrasonic signal at a location downstream of said second upstream location;

(g) transmitting through said first portion a fourth ultrasonic signal from a second downstream location, said fourth ultrasonic signal reflecting of said surface of said stratified flow;

(h) receiving said fourth ultrasonic signal at a location upstream of said second downstream location;

(i) computing the amount of said stratified flow in said conduit based on the travel times of said first, second, third, and fourth ultrasonic signals.

18. The method of claim 17, wherein said first portion is not said stratified flow.

19. The method of claim 17, wherein said first portion is a gas.

20. The method of claim 17, wherein said first and second ultrasonic signals travel in a generally horizontal direction.

21. The method of claim 20, wherein said first and second ultrasonic signals are used to measure a speed of sound for a portion of said conduit not carrying said stratified flow.

22. The method of claim 17, wherein said first and second ultrasonic signals travel in generally horizontal directions and said third and fourth ultrasonic signals travel in generally vertical directions.

23. The method of claim 22, wherein said first and second ultrasonic signals are used to measure a speed of sound for a portion of said conduit not carrying said stratified flow and said third and fourth ultrasonic signals are used to measure a second speed of sound corresponding to a level of said stratified flow in said conduit.

24. The method of claim 17, wherein said first ultrasonic signal is transmitted by a first transducer and received by a second transducer, said second ultrasonic signal is transmitted by said second transducer and received by said first transducer, said third ultrasonic signal is transmitted by a third transducer and received by a fourth transducer, and said fourth ultrasonic signal is transmitted by said fourth transducer and received by said third transducer.

25. The method of claim 17, wherein said step of computing includes calculating a first measured speed of sound from said first and second ultrasonic signals, and a second measured speed of sound based on said third and fourth ultrasonic signals, the discrepancy between said first and second measured speeds of sound indicating the level of said stratified flow.

26. The method of claim 17, wherein said method is performed by a two-chord ultrasonic meter.

27. A flow meter suitable to determine the level of stratified flow through a conduit, comprising:

a first transducer suitable to transmit a first ultrasonic signal across said conduit and through a first medium traveling through said first medium from an upstream end to a downstream end;

a second transducer suitable to receive said first ultrasonic signal and to transmit to said first transducer a second ultrasonic signal;

a third transducer suitable to transmit a third ultrasonic signal through said first medium, said third ultrasonic signal positioned to reflect from a surface of said stratified flow; and

a processor to compute an upstream transit time for said first signal, a downstream time for said second signal, and a level reflection transit time for said third ultrasonic signal, said processor further computing a level of stratified flow based upon said upstream transit time, said downstream transit time, and said level detection transit time.

28. The flow meter of claim 27, further comprising:

a fourth transducer suitable to receive said third ultrasonic signal and to transmit to said third transducer a second level reflection transit time, wherein said processor additionally uses said second level reflection transit time to compute said level of stratified flow.

29. The flow meter of claim 28, wherein a first speed of sound is computed based on said first and second ultrasonic signals and a second speed of sound is computed based on said third and fourth ultrasonic signals, the difference in said first and second speeds of sound providing a level of said stratified flow.

30. The flow meter of claim 27, wherein said first and second ultrasonic signals define a generally horizontal chord and said third ultrasonic signal defines a generally vertical chord.

31. A flow meter suitable to determine an amount of stratified flow through a pipeline, comprising:

means for generating a first set of signals through said pipeline;

means for generating a second set of signals through said pipeline, said second set of signals reflecting from a stratified flow of fluid if any; and

means for computing said amount of stratified flow based upon differences in times of flight between said first set of signals and said second set of signals.